Risk Reduction using DDP (Defect Detection and Prevention): Software Support for, and Software Applications of.

[RE'01 Research Demonstration Proposal Abstract]

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The DDP Process: Risk assessment and mitigation is the focus of the Defect Detection and Prevention (DDP) process, and its accompanying customized tool support. Dr. Steven Cornford (JPL) leads DDP's development and application to JPL spacecraft technology assessments and planning, both hardware and software. The DDP process deals with the following concepts:

- *Requirements* – whatever the system hardware/software is to achieve. In DDP, requirements are weighted, reflecting their relative importance.
- *Failure Modes (FMs)* – the things that, should they occur, will lead to loss of requirements. In DDP, FMs can be given an a-prori likelihood (the chance of the FM occurring, if nothing is done to inhibit it).
- *"PACTs"* – the things that you could choose to do reduce the likelihood of failure modes and/or reduce their impact on requirements. PACTs include Preventative measures, Analyses, process Controls and Tests. Each PACT has costs: budget, schedule, mass (for physical artifacts), etc.

Since not every FM affects every requirement to the same extent, and since not every PACT mitigates every FM to the same degree, DDP also deals with the additional concepts of:

- *Impacts* – for each Requirement x FM pair, how much of that Requirement will be lost should that FM occur.
- *Effects* – for each PACT x FM pair, how much of a mitigating effect that PACT will achieve against that FM.

Relevance of DDP to Requirements Engineering: The DDP process has been used on real spacecraft project components and technologies, both hardware and software, to achieve the following benefits:

- Elicitation – spacecraft typify projects in which *expertise from multiple disciplines is combined.* DDP supports the *on-the-fly elicitation and capture* of project-specific information, as well as use of pre-assembled knowledge bases.
- Selection – since there are far more PACTs (tests, analyses, etc.) that could be done than there are resources to pay for them, their judicious selection must take into account their costs and their benefits. DDP's manipulation of quantitative data facilitates the *cost-effective selection* of PACTs. DDP also has been used to *trigger and guide requirements negotiation* – requirements whose attainment is proving the most

costly (because they are at high risk, and the risk-mitigating PACTs are costly)

- Assessment, Tailoring and Understanding – the net result of a DDP application is a *tailored assessment of the project's risk profile,* and an *understanding of why activities are being done* (namely, to mitigate the risks of specific FMs on requirements).

Overall, DDP *allows risk to be traded as a resource,* as one would with cost, schedule, functionality,…

Research Demonstration: The custom tool support constructed for the DDP process will be shown. This tool combines features for:

- information capture and organization in real-time
- automatic calculation of derived information pertinent to requirements (for each requirement, how much at risk each it is), FMs (how much damage each is causing) and PACTs (how much benefit does each provide)
- a variety of cogent visualizations that allow users to explore the risk, requirements and mitigations landscape
- decision support that helps users in their making of choices.

Software-specific customizations: The DDP tool has been populated with information specific to software development efforts. In particular, best-practice knowledge drawn from the SEI: software development risks (which in DDP become the "FMs"), and CMM recommended activities (which in DDP become the PACTs). The cross-linking of these (done by Jim Kiper, U. of Miami, Ohio), permits an understanding of which activities address which risks, they key to effective planning of cost-effective risk-reducing software developments.

The DDP tool has also been augmented to interact with another NASA-developed tool, Ask Pete http://tkurtz.grc.nasa.gov/pete, in such a way that Ask Pete's capabilities to do estimation and planning feed as initial data into DDP for project-specific customization and cost/risk/requirements trades.

Finally, the software customized version of the DDP tool is serving as a springboard for ongoing collaboration with other requirements research, including stakeholder-based negotiation (Hoh In, Texas A&M) and machine learning based search, optimization and sensitivity analysis (Tim Menzies, U. British Columbia). It is hoped that this demo will spur interest in further such collaborations.